

Figure 1. Schematic of Kuna Butte study area located approximately 3 km south of Kuna, Ada County, Idaho. Active (1996) burrowing owl nest sites are indicated by filled symbols. Scale: 1 in. = approx. 0.8 mi.

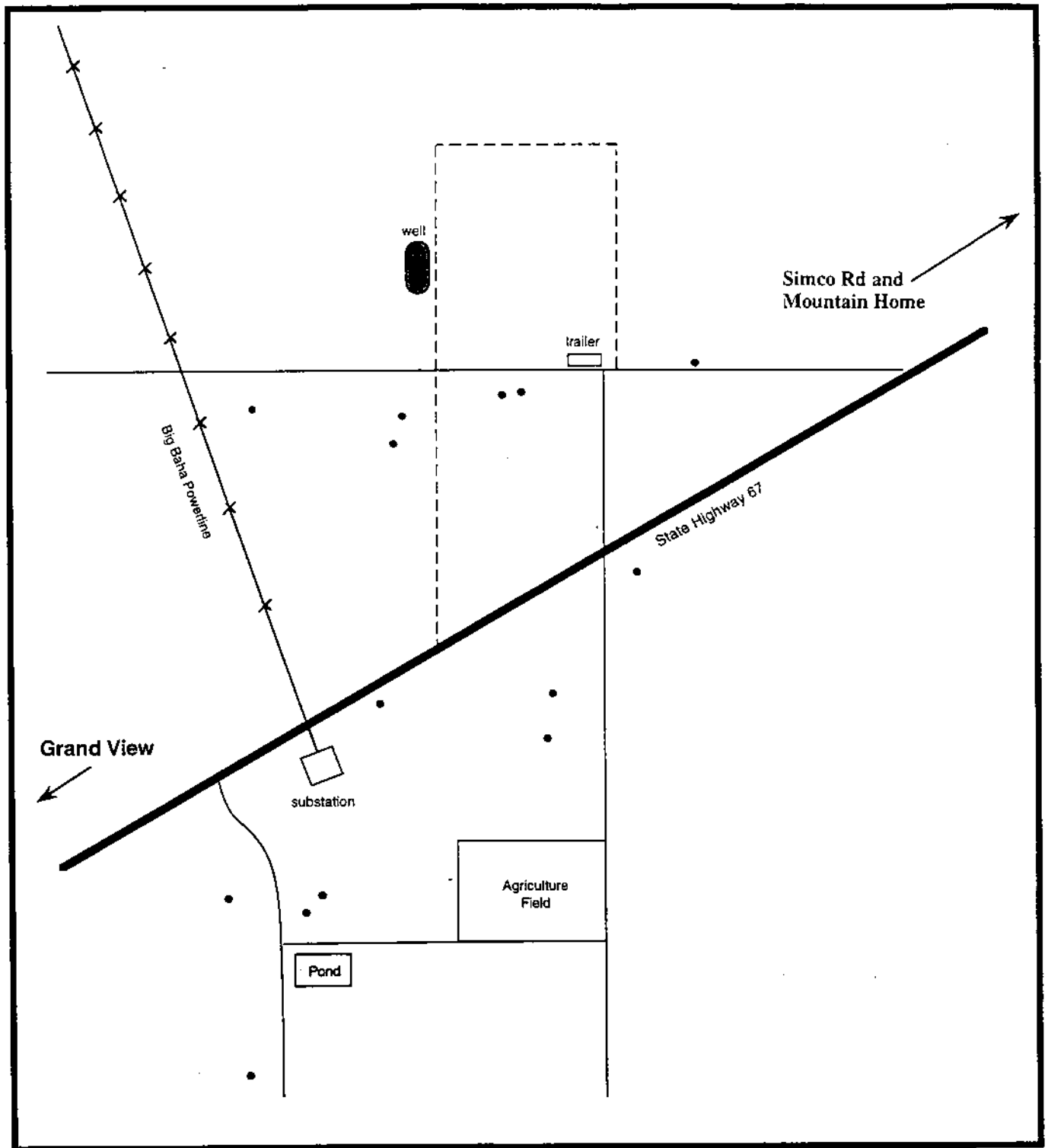


Figure 2. Schematic of Grand View study area located approximately 8 km north northeast of Grand View in Elmore County, Idaho along State Highway 67. Active (1996) burrowing owl nest sites are indicated by filled symbols. Scale: 1 in. = approx. 0.25 mi.

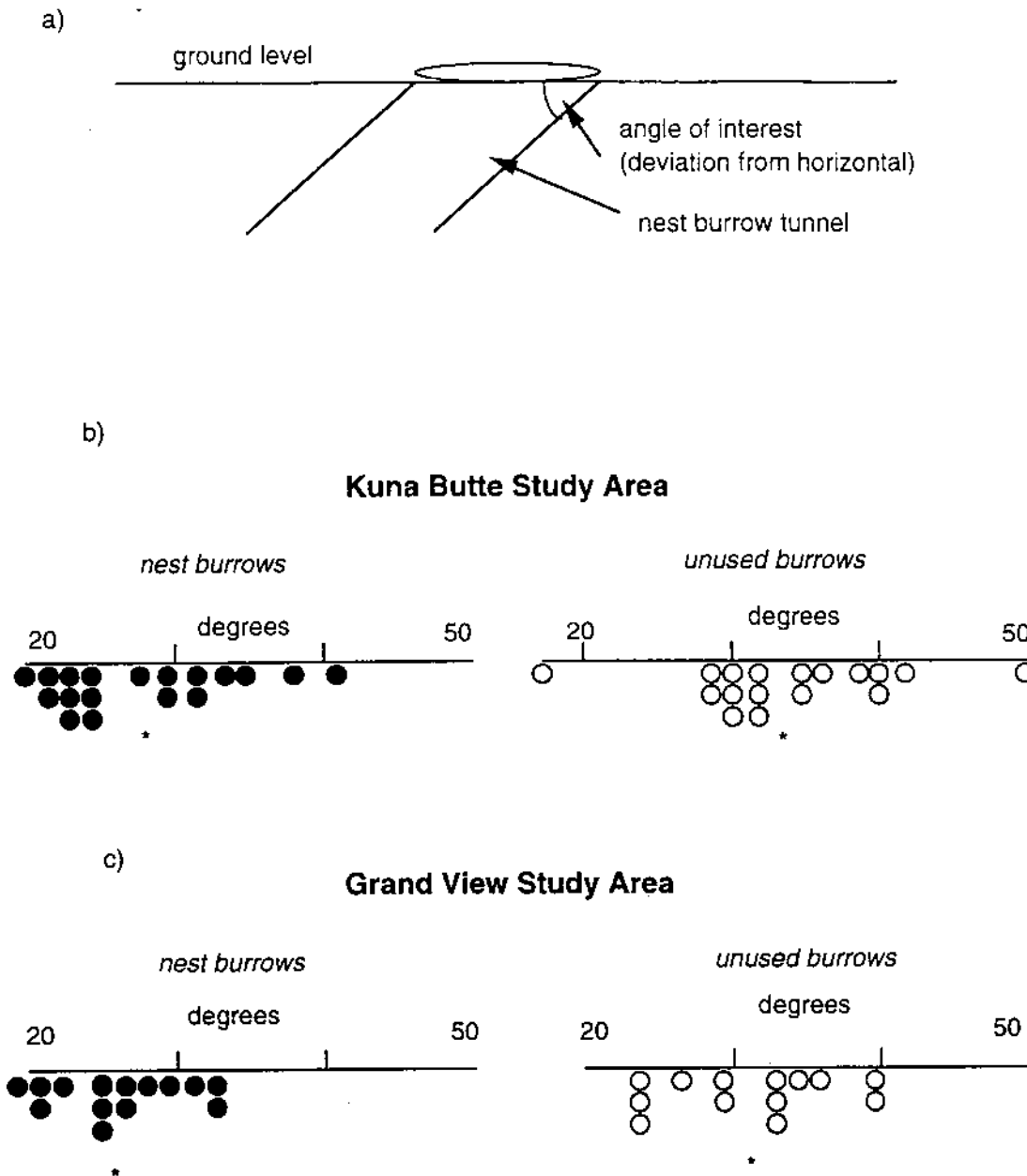
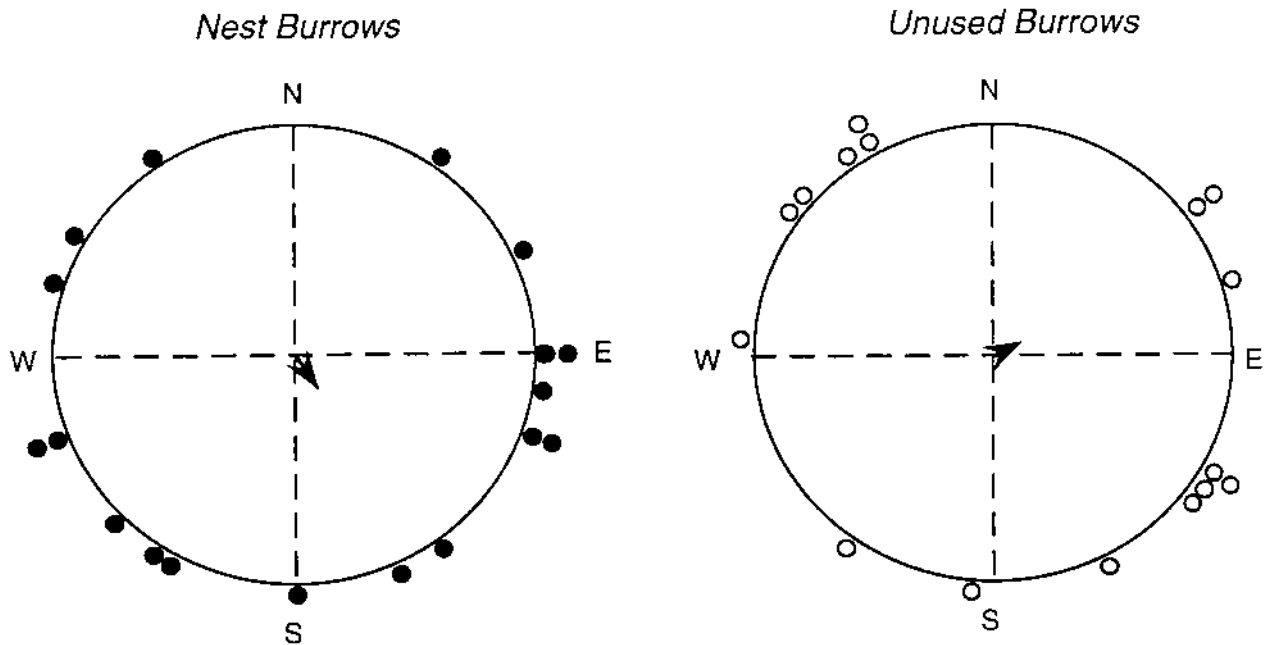


Figure 3. (a) Illustration depicting tunnel entrance angle and its measurement. (b) distribution and mean (\*) of tunnel angles for used and unused burrows in the Kuna Butte study area. (c) distribution and mean (\*) of tunnel angles for used and unused burrows in the Grand View study area.

a)

**Kuna Butte Study Area**

b)

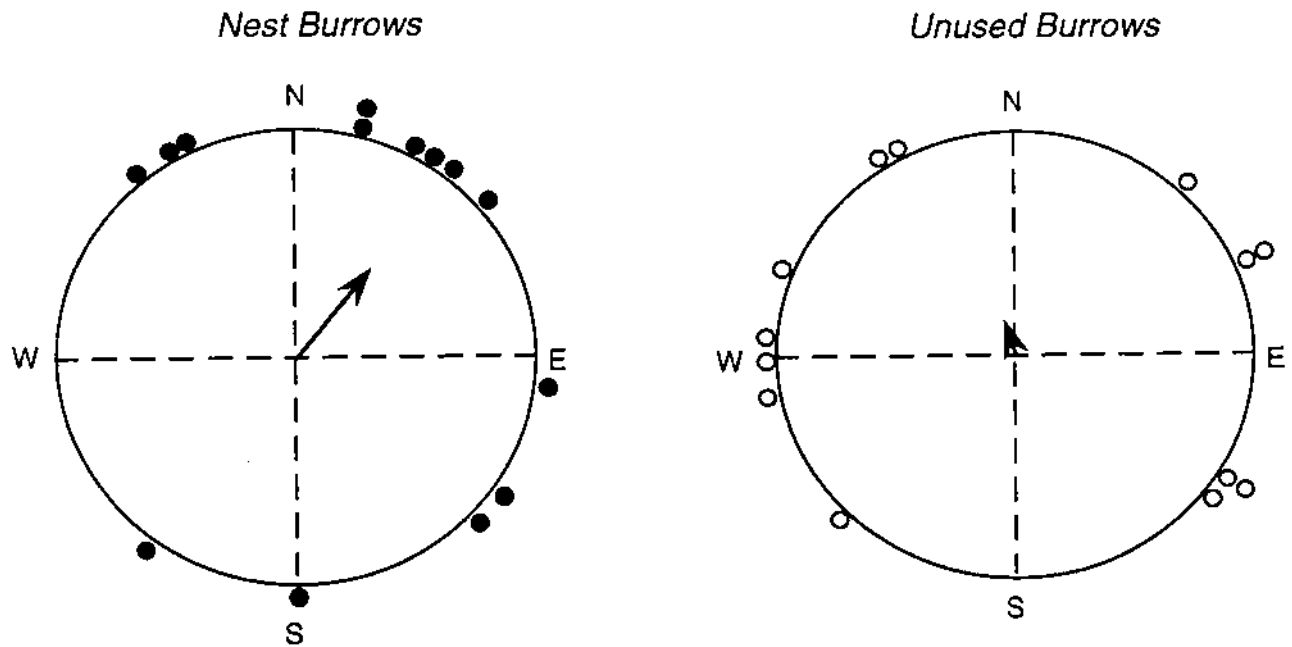
**Grand View Study Area**

Figure 4. Circular scattergrams of orientation of burrow entrances for (a) used and unused burrows in the Kuna Butte study area, and (b) used and unused burrows in the Grand View study area. Mean orientation is signified by the arrow in each scattergram and the concentration of the data points ( $r$ ) is indicated by the length of the arrow in each case (Kuna Butte used and unused  $r = 0.19$  and  $0.06$ , respectively; Grand View used and unused  $r = 0.42$  and  $0.15$ , respectively).

vegetation type

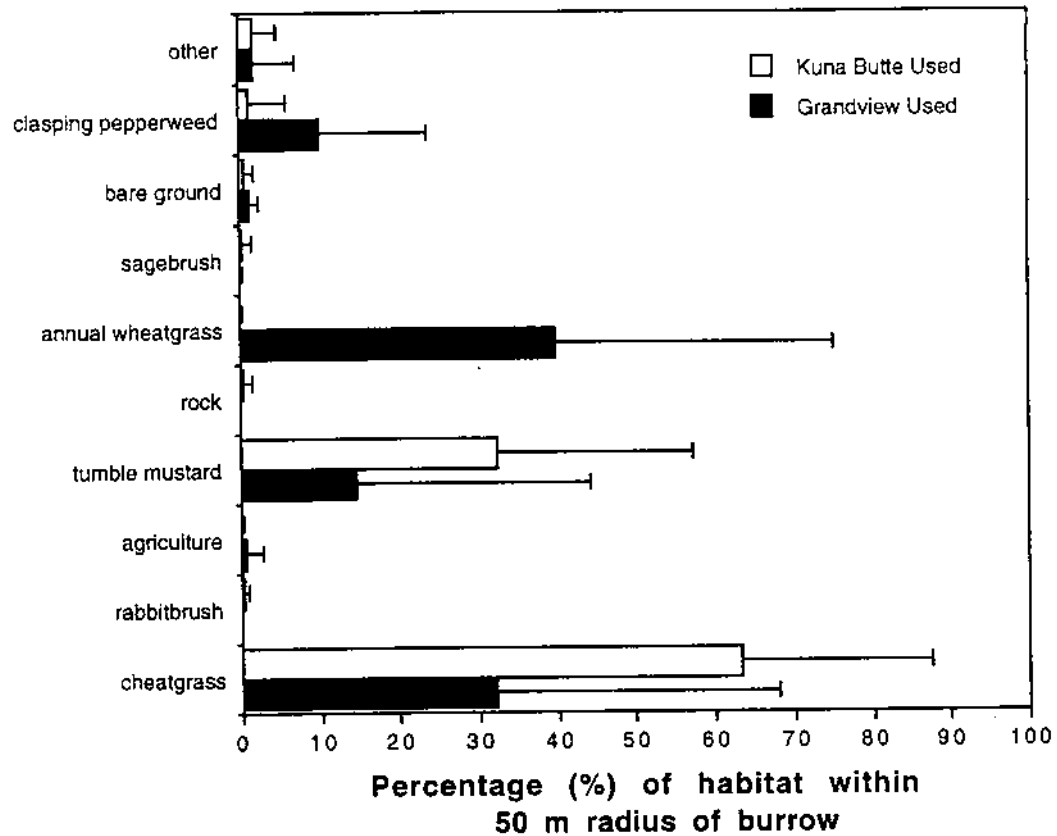


Figure 5. Mean ( $\pm$  SD) percentage of 10 habitat types within 50 m radius of nest burrows in the Kuna Butte (N = 18) and Grand View (N = 14) study areas (see text for plant scientific names).

vegetation type

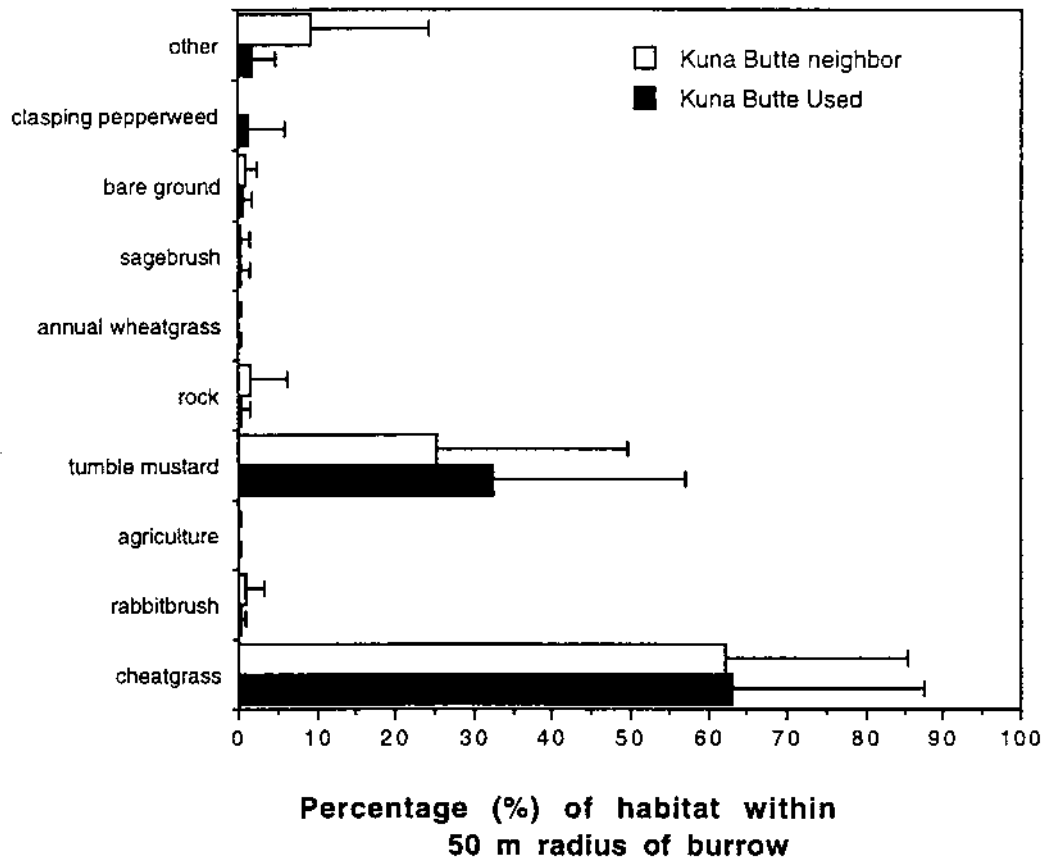


Figure 6. Mean ( $\pm$  SD) percentage of 10 habitat types within 50 m radius of used (N = 18) and nearest neighbor, unused burrows (N = 18) in the Kuna Butte study area (see text for plant scientific names).

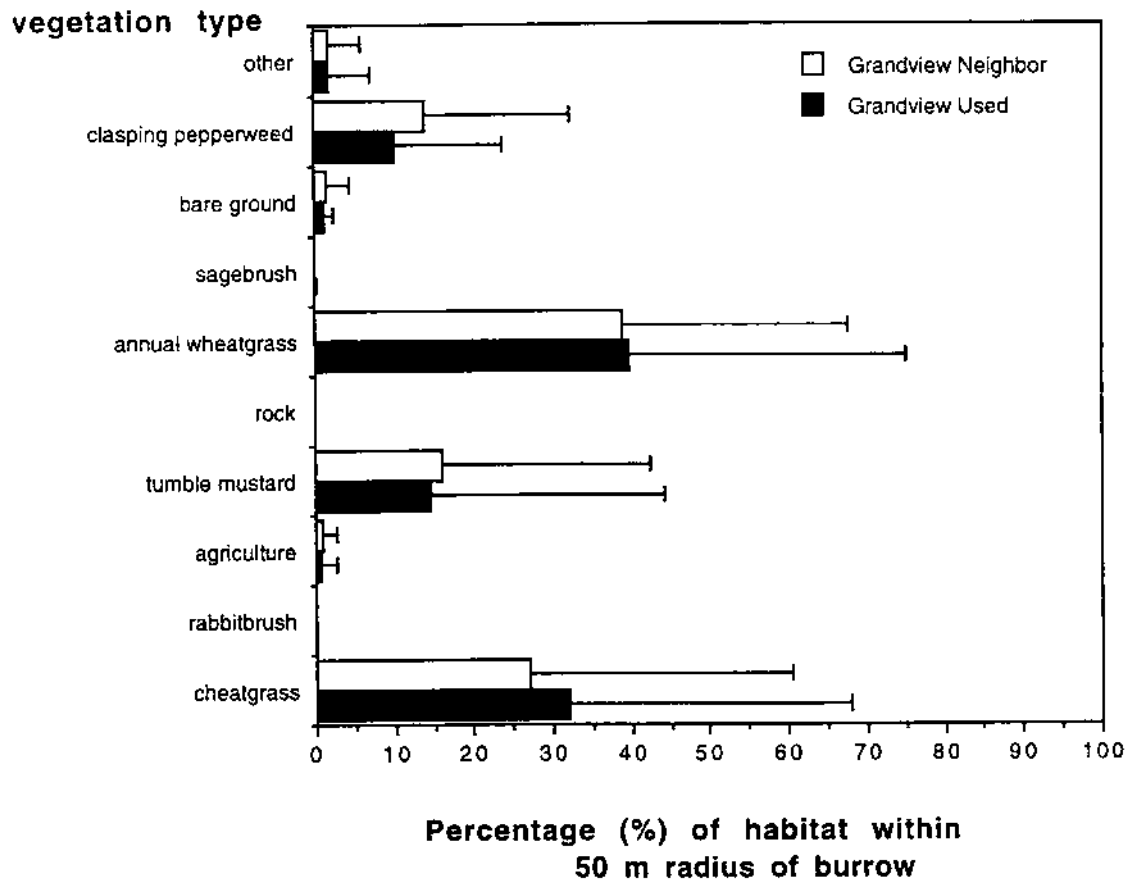


Figure 7. Mean ( $\pm$  SD) percentage of 10 habitat types within 50 m radius of used (N = 14) and nearest neighbor, unused burrows (N = 13) in the Grand View study area (see text for plant scientific names).

Table 1. Return of burrowing owls to the Kuna Butte study area in 1996, reflecting between-year movements.

Band Number	Original Location (Year)	Age When First Observed	Sex	1996 Nest Location	Distance <sup>a</sup> (km)	Breeding Successful in 1996?
1204-43628 <sup>b</sup>	Kuna Butte #6 (1994)	Juvenile	Male	Effluent Field South	1.84	Yes
1204-43762	Dairy #2 (1995)	Adult	Male	Dairy #2	0.00	Yes
1204-43679	Kuna Butte #1b (1995)	Adult	Female	Kuna Butte #5	0.11	Yes
1204-43681	Kuna Cave #1 (1995)	Adult	Female	Kuna Cave #3	0.50	Yes
1204-43697	Kuna Cave #2 (1995)	Juvenile	Female	Dairy #7	4.80	No
unknown <sup>c</sup>	unknown (1995)	Juvenile	Male	Kuna Butte #7	-	Yes
unmarked <sup>d</sup>	Sewage Pond #2 (1995)	Adult	Male	Sewage Pond #2	0.00	Yes

<sup>a</sup>reflects *breeding dispersal* distance if adult when initially banded, and *natal dispersal* distance if juvenile when first banded.

<sup>b</sup>not detected in study area during 1995, so 1996 breeding site may not represent first breeding attempt.

<sup>c</sup>marked with radio as nestling in 1995 but not recaptured during 1996.

<sup>d</sup>unmarked adult male presumed to be same male in 1995 and 1996 based on aggressive nest defense.



Table 2. Pattern of nest burrow (re-) use in the Kuna Butte study area (1994 - 1996). X = burrow used for nesting; (F) = nesting attempt failed and no young fledged; O = burrow not used for nesting, confirmed; NM = burrow not monitored for use during our study; - = burrow likely not used. Similar data are not available for the Grand View study area, as 1996 was our first year of work in this area.

Nest Name	1994	1995	1996
Dairy #1	X (F)	O	O
Dairy #2	X	X	X
Dairy #3	X	O	O
Dairy #4	X (F)	O	O
Dairy #5	X (F)	O	O
Dairy #6	X	X	X
Dairy #7	-	-	X (F)
Sewage Pond #1	X	X	X
Sewage Pond #2	-	X	X
Kuna Butte #1a	X (F)	destroyed	destroyed
Kuna Butte #1b	-	X	X
Kuna Butte #2	X	X	O
Kuna Butte #3	X	O	O
Kuna Butte #4	X (F)	O	O
Kuna Butte #5	X	X	X
Kuna Butte #6	X	X	O
Kuna Butte #7	-	-	X
Effluent Field North	-	-	X
Effluent Field South	-	-	X
Kuna Cave #1	NM	X	O
Kuna Cave #2	NM	X	X
Kuna Cave #3	NM	X	X
Swan Falls 1	X	O	O
Swan Falls South	-	X (F)	O
Swan Falls #3	-	-	X
Swan Falls #4	-	-	X
J. Hayes	(likely used) <sup>a</sup>	X	X
B. Stewart #1	O	X	X
B. Stewart #2	O	X	X
IBP #1a	X (F)	O	O
IBP #1b	-	X	O
IBP #2	X	X	X
Indian Creek S.	-	X	O
Indian Creek W.	NM	X	O

Table 2. Continued.

Nest Name	1994	1995	1996
IAP #1	-	X	O
IAP #2	NM	X	O

<sup>a</sup>free-flying juveniles observed in vicinity of burrow but nesting in burrow not confirmed.

Table 3. Active nest name, identity of breeding adults, and number of nestlings or fledglings banded and observed in the Kuna Butte and Grand View study areas during the 1996 breeding period. Unless otherwise indicated, adults were initially banded in 1996. Dashes (-) indicate breeding owls that remained unbanded.

Nest Name	Adult Male	Adult Female	# Young Banded (observed)
<i>Kuna Butte Study Area</i>			
Dairy #2	1204-43672 <sup>a</sup>	1204-43749	4 (4)
Dairy #6	-	1204-43758	1 (5)
Dairy #7	-	1204-43697 <sup>b</sup>	0 (0)
Sewage Pond #1	1204-43767	1204-43748	5 (5)
Sewage Pond #2	-	1204-43753	5 (7)
Kuna Butte #1b	-	1204-43751	2 (6)
Kuna Butte #5	-	1204-43679 <sup>c</sup>	4 (4)
Kuna Butte #7	(?) nestling from 1995 <sup>d</sup>	614-89639	2 (2)
Effluent Field North	-	-	7 (7)
Effluent Field South	1204-43628 <sup>e</sup>	-	6 (6)
Swan Falls #3	614-89623	1204-43765	4 (5)
Swan Falls #4	-	-	4 (4)
Kuna Cave #2	-	-	5 (5)
Kuna Cave #3	-	1204-43681 <sup>f</sup>	7 (7)
John Hayes #1	-	1204-43756	2 (2)
B. Stewart #1	-	-	3 (4)
B. Stewart #2	-	1204-43755	3 (4)

Table 3. Continued.

Nest Name	Adult Male	Adult Female	# Young Banded (observed)
IBP #2	-	-	4 (5)
<i>Grand View Study Area</i>			
Trailer #1	1204-43780	-	3 (5)
Trailer #2	1204-43797	1204-43783	6 (6)
Trailer #3	-	-	2 (2)
Well #1	1204-43779	-	5 (5)
Well #2	-	1204-43778	4 (4)
Baha #1	1204-43795	614-89652	1 (5)
Trailerview	-	1204-43785	0 (0)
Grandview #19	-	-	3 (4)
Grandview #2	614-89677	-	4 (7)
Substation South #1	-	-	5 (5)
Substation South #2	-	-	10 (10)
Substation South #3	-	-	0 (4)
Substation South #4	-	-	8 (8)
Substation East #1	-	-	5 (6)

<sup>a</sup>banded as breeding male at this burrow in 1995.

<sup>b</sup>banded as nestling at Kuna Cave #2 in 1995.

<sup>c</sup>banded as breeding female at Kuna Butte #1b in 1995.

<sup>d</sup>banded and radio-tagged as nestling in 1995 but not recaptured during 1996.

<sup>e</sup>banded as nestling at Kuna Butte #6 nest in 1994.

<sup>f</sup>banded as breeding female at Kuna Cave #1 in 1995.

Table 4. Characteristics ( $\bar{x} \pm \text{SD}$ ) of burrowing owl nest burrows and nearest, apparently suitable unoccupied burrows (neighbor) in the Kuna Butte and Grand View study areas in southwestern Idaho, 1996.

Variable	<u>Occupied Burrows</u>				<u>Unused Burrows</u>			
	Kuna Butte (N = 18)	Grand View (N = 14)	Fa	P	Kuna Butte (N = 18)	Fb	P	Grand View (N = 13)
Entrance height (cm)	15.8 $\pm$ 3.7	13.5 $\pm$ 2.9	3.50	0.07	15.9 $\pm$ 4.2	2.29	0.14	11.7 $\pm$ 3.3
Entrance width (cm)	21.3 $\pm$ 3.3	18.8 $\pm$ 3.0	4.86	0.04	20.6 $\pm$ 3.6	0.09	0.77	18.5 $\pm$ 2.5
Height of mound (cm)	8.0 $\pm$ 4.8	8.8 $\pm$ 4.4	0.24	0.63	7.5 $\pm$ 6.0	0.01	0.93	8.7 $\pm$ 4.8
Nearest suitable burrow (m)	9.4 $\pm$ 10.5	26.4 $\pm$ 23.0	7.86	0.01	-	-	-	-
Number of burrows within 10 m	2.9 $\pm$ 2.7	1.1 $\pm$ 1.9	4.44	0.04	2.8 $\pm$ 1.5	0.42	0.52	1.6 $\pm$ 1.85
Orientation of entrance ( $^{\circ}$ )	163.1 $\pm$ 104.8	39.2 $\pm$ 75.9	9.51	0.06	45.8 $\pm$ 135.1	3.91	0.06	342.6 $\pm$ 112.6
Angle of entrance tunnel ( $^{\circ}$ ) <sup>c</sup>	28.2 $\pm$ 5.6	26.3 $\pm$ 4.2	1.10	0.30	33.7 $\pm$ 1.8	5.73	0.02	30.4 $\pm$ 1.8

<sup>a</sup>univariate anovas or Watson's F-test (see text for results of multivariate analysis of variance, MANOVA).

<sup>b</sup>univariate comparison with used burrows in respective study area (see text for results of MANOVA).

<sup>c</sup>deviation (in degrees) from horizontal (see Fig. 3 for illustration).

Table 5. Characteristics ( $\bar{x} \pm \text{SD}$ ) of vegetation and other features of burrowing owl nest burrows and nearest, apparently suitable, unoccupied burrows (neighbor) in the Kuna Butte and Grand View study areas in southwestern Idaho, 1996.

Variable	<u>Occupied Burrows</u>				<u>Unused Burrows</u>			
	Kuna Butte (N = 18)	Grandview (N = 14)	Fa (N = 14)	P	Kuna Butte (N = 18)	Fb (N = 18)	P	Grandview (N = 13)
Vegetation height 0.5 m from burrow (cm)	51.6 $\pm$ 11.8 <sup>c</sup>	22.8 $\pm$ 9.4	53.60	0.001	49.2 $\pm$ 14.8 <sup>c</sup>	0.25	0.62	20.2 $\pm$ 7.7
Vegetation height 2.0 m from burrow (cm)	52.1 $\pm$ 12.0 <sup>c</sup>	23.9 $\pm$ 5.6	63.31	0.001	50.3 $\pm$ 13.4 <sup>c</sup>	0.15	0.70	26.3 $\pm$ 7.8
Distance to perch (m)	17.0 $\pm$ 21.1	38.9 $\pm$ 33.2	6.25	0.02	18.5 $\pm$ 17.4	0.11	0.74	33.2 $\pm$ 18.6
Height of perch (cm)	100.8 $\pm$ 30.6	98.8 $\pm$ 50.9	0.01	0.93	100.2 $\pm$ 29.9	0.01	0.96	83.9 $\pm$ 54.9
Distance to irrigated agriculture (m)	239.1 $\pm$ 195.2	125.2 $\pm$ 140.6	1.71	0.20	246.7 $\pm$ 211.6	0.01	0.95	127.4 $\pm$ 147.0
Distance to road (m)	119.5 $\pm$ 178.4	56.4 $\pm$ 27.7	2.16	0.15	115.7 $\pm$ 180.4	0.01	0.95	56.2 $\pm$ 47.6
Distance to water (m)	160.3 $\pm$ 130.2	125.2 $\pm$ 140.8	0.05	0.82	162.5 $\pm$ 134.7	0.01	0.94	130.5 $\pm$ 148.0

<sup>a</sup>univariate anovas (see text for results of multivariate analysis of variance, MANOVA).

<sup>b</sup>univariate comparison with used burrows in respective study area (see text for results of MANOVA).

<sup>c</sup>N = 16 because two sites burned prior to measurements.

**APPENDIX A:**  
**Banding Data**

Band numbers, date of marking, age, sex, color-marking on right and left legs, and location for burrowing owls banded near Kuna, Ada County and near Grand View, Elmore County, Idaho during 1996.

**NOTE:**

**Age:**

AHY = after hatching year, adult bird

L = local (a young bird incapable of sustained flight)

HY = hatching year (birds older than 35 days of age known to have hatched during the 1996 calendar year but capable of sustained flight)

**Sex:**

M = male

F = female (sexed based on behavior and brood patch)

U = unknown

**Color band:**

AL = aluminum

R = red

B = blue

G = green

Y = yellow

W = white

P = pink

Band Number	Date	Age	Sex	Right	Left	Area
1204-43743	28-May	L	U	Y,AL	P,W	Kuna
1204-43744	28-May	L	U	Y,AL	P,P	Kuna
1204-43745	28-May	L	U	W,AL	P,R	Kuna
1204-43746	28-May	L	U	W,AL	R,R	Kuna
1204-43747	28-May	L	U	W,AL	R,G	Kuna
1204-43748	28-May	AHY	F	W,AL	R,Y	Kuna
1204-43749	29-May	AHY	F	W,AL	R,W	Kuna
1204-43750	29-May	L	U	W,AL	R,P	Kuna
1204-43751	29-May	AHY	F	W,AL	B,R	Kuna
1204-43752	29-May	L	U	W,AL	B,B	Kuna
1204-43753	30-May	AHY	F	W,AL	B,G	Kuna
1204-43754	31-May	L	U	W,AL	B,Y	Kuna
1204-43755	31-May	AHY	F	W,AL	B,W	Kuna
1204-43756	31-May	AHY	F	W,AL	B,P	Kuna
1204-43757	1-Jun	L	U	W,AL	G,R	Kuna
1204-43758	1-Jun	AHY	F	W,AL	G,B	Kuna
1204-43759	1-Jun	L	U	W,AL	G,G	Kuna
1204-43760	1-Jun	L	U	W,AL	G,Y	Kuna
1204-43761	3-Jun	L	U	W,AL	G,W	Kuna
1204-43762	3-Jun	L	U	W,AL	G,P	Kuna
1204-43763	3-Jun	L	U	W,AL	Y,R	Kuna



1204-43764	3-Jun	L	U	W,AL	Y,B	Kuna
1204-43765	3-Jun	AHY	F	W,AL	Y,G	Kuna
1204-43766	3-Jun	L	U	W,AL	Y,Y	Kuna
1204-43767	4-Jun	AHY	M	W,AL	Y,W	Kuna
1204-43768	4-Jun	L	U	W,AL	Y,P	Kuna
1204-43769	4-Jun	L	U	W,AL	W,R	Kuna
1204-43770	4-Jun	L	U	W,AL	W,B	Kuna
1204-43771	4-Jun	L	U	W,AL	W,G	Kuna
1204-43772	4-Jun	L	U	W,AL	W,Y	Kuna
1204-43773	5-Jun	L	U	W,AL	W,W	Kuna
1204-43774	5-Jun	L	U	W,AL	W,P	Kuna
1204-43775	5-Jun	HY	U	W,AL	P,R	Kuna
1204-43776	6-Jun	L	U	W,AL	P,B	Grand View
1204-43777	6-Jun	L	U	W,AL	P,G	Grand View
1204-43778	6-Jun	AHY	F	W,AL	P,Y	Grand View
1204-43779	6-Jun	AHY	M	W,AL	P,W	Grand View
1204-43780	6-Jun	AHY	M	W,AL	P,P	Grand View
1204-43781	6-Jun	L	U	P,AL	R,R	Grand View
1204-43782	8-Jun	HY	U	P,AL	R,B	Grand View
1204-43783	8-Jun	AHY	F	P,AL	R,G	Grand View
1204-43784	8-Jun	L	U	P,AL	R,Y	Grand View
1204-43785	8-Jun	L	U	P,AL	R,W	Grand View
1204-43786	8-Jun	AHY	F	P,AL	R,P	Grand View
1204-43787	8-Jun	L	U	P,AL	B,R	Grand View
1204-43788	8-Jun	L	U	P,AL	B,B	Grand View
1204-43789	8-Jun	L	U	P,AL	B,G	Grand View
1204-43790	8-Jun	L	U	P,AL	B,Y	Grand View
1204-43791	10-Jun	HY	U	P,AL	B,W	Grand View
1204-43792	10-Jun	L	U	P,AL	B,P	Grand View
1204-43793	10-Jun	L	U	P,AL	G,R	Grand View
1204-43794	10-Jun	L	U	P,AL	G,B	Grand View
1204-43795	10-Jun	AHY	M	P,AL	G,G	Grand View
1204-43796	10-Jun	L	U	P,AL	G,Y	Grand View
1204-43797	10-Jun	L	U	P,AL	G,W	Grand View
1204-43798	11-Jun	AHY	M	P,AL	G,P	Grand View
1204-43799	11-Jun	L	U	P,AL	Y,R	Grand View
1204-43800	11-Jun	L	U	P,AL	Y,B	Grand View
614-89601	11-Jun	L	U	P,AL	Y,G	Grand View
614-89602	11-Jun	L	U	P,AL	Y,Y	Grand View
614-89603	11-Jun	L	U	P,AL	Y,W	Grand View
614-89604	11-Jun	L	U	P,AL	Y,P	Grand View
614-89605	13-Jun	L	U	P,AL	W,R	Kuna
614-89606	13-Jun	L	U	P,AL	W,B	Kuna
614-89607	13-Jun	L	U	P,AL	W,G	Kuna
614-89608	13-Jun	L	U	P,AL	W,Y	Kuna
614-89609	13-Jun	L	U	P,AL	W,W	Kuna
614-89610	14-Jun	L	U	P,AL	W,P	Kuna
614-89611	14-Jun	L	U	P,AL	P,R	Kuna
614-89612	14-Jun	L	U	P,AL	P,B	Kuna
614-89613	14-Jun	L	U	P,AL	P,G	Kuna
614-89614	14-Jun	L	U	P,AL	P,Y	Kuna
614-89615	14-Jun	L	U	P,AL	P,W	Kuna
614-89616	16-Jun	L	U	P,AL	P,P	Kuna
614-89617	16-Jun	L	U	R,R	R,AL	Kuna

614-89618	17-Jun	L	U	R,B	R,AL	Kuna
614-89619	17-Jun	L	U	R,G	R,AL	Kuna
614-89620	17-Jun	L	U	R,Y	R,AL	Kuna
614-89621	17-Jun	L	U	R,P	R,AL	Kuna
614-89622	18-Jun	L	U	R,W	R,AL	Kuna
614-89623	18-Jun	AHY	M	B,R	R,AL	Kuna
614-89624	18-Jun	L	U	B,B	R,AL	Kuna
614-89625	19-Jun	L	U	B,G	R,AL	Kuna
614-89626	19-Jun	L	U	B,Y	R,AL	Kuna
614-89627	19-Jun	L	U	B,W	R,AL	Kuna
614-89628	19-Jun	L	U	B,P	R,AL	Kuna
614-89629	19-Jun	L	U	G,R	R,AL	Kuna
614-89630	19-Jun	L	U	G,B	R,AL	Kuna
614-89631	19-Jun	L	U	G,G	R,AL	Kuna
614-89632	19-Jun	L	U	G,Y	R,AL	Kuna
614-89633	19-Jun	L	U	G,W	R,AL	Kuna
614-89634	20-Jun	L	U	G,P	R,AL	Kuna
614-89635	20-Jun	L	U	Y,R	R,AL	Kuna
614-89636	20-Jun	L	U	Y,B	R,AL	Kuna
614-89637	24-Jun	HY	U	Y,G	R,AL	Kuna
614-89638	24-Jun	HY	U	Y,Y	R,AL	Kuna
614-89639	24-Jun	AHY	F	Y,W	R,AL	Kuna
614-89640	24-Jun	L	U	Y,P	R,AL	Kuna
614-89641	26-Jun	L	U	W,R	R,AL	Kuna
614-89642	26-Jun	L	U	W,B	R,AL	Kuna
614-89643	26-Jun	L	U	W,G	R,AL	Kuna
614-89644	26-Jun	L	U	W,Y	R,AL	Kuna
614-89645	28-Jun	L	U	W,W	R,AL	Kuna
614-89646	28-Jun	L	U	W,P	R,AL	Kuna
614-89647	28-Jun	L	U	P,R	R,AL	Kuna
614-89648	9-Jul	L	U	P,B	R,AL	Kuna
614-89649	26-Jul	L	U	P,G	R,AL	Kuna
614-89650	31-Jul	L	U	P,Y	R,AL	Kuna
614-89651	13-Jun	L	U	P,W	R,AL	Grand View
614-89652	13-Jun	AHY	F	P,P	R,AL	Grand View
614-89653	13-Jun	L	U	R,R	B/AL	Grand View
614-89654	13-Jun	L	U	R,B	B/AL	Grand View
614-89655	13-Jun	L	U	R,G	B/AL	Grand View
614-89656	13-Jun	L	U	R,Y	B/AL	Grand View
614-89657	13-Jun	L	U	R,W	B/AL	Grand View
614-89658	13-Jun	L	U	R,P	B/AL	Grand View
614-89659	17-Jun	L	U	B,R	B/AL	Grand View
614-89660	17-Jun	L	U	B,B	B/AL	Grand View
614-89661	17-Jun	L	U	B,G	B/AL	Grand View
614-89662	17-Jun	L	U	B,Y	B/AL	Grand View
614-89663	17-Jun	L	U	B,W	B/AL	Grand View
614-89664	17-Jun	L	U	B,P	B/AL	Grand View
614-89665	17-Jun	L	U	G,R	B/AL	Grand View
614-89666	18-Jun	L	U	G,B	B/AL	Grand View
614-89667	18-Jun	L	U	G,G	B/AL	Grand View
614-89668	18-Jun	L	U	G,Y	B/AL	Grand View
614-89669	20-Jun	L	U	G,W	B/AL	Grand View
614-89670	20-Jun	HY	U	G,P	B/AL	Grand View
614-89671	20-Jun	L	U	Y,R	B/AL	Grand View

614-89672	20-Jun	L	U	Y,B	B/AL	Grand View
614-89673	22-Jun	L	U	Y,G	B/AL	Grand View
614-89674	22-Jun	L	U	Y,Y	B/AL	Grand View
614-89675	22-Jun	L	U	Y,W	B/AL	Grand View
614-89676	22-Jun	L	U	Y,P	B/AL	Grand View
614-89677	22-Jun	AHY	F	W,R	B/AL	Grand View
614-89678	22-Jun	HY	U	W,B	B/AL	Grand View
614-89679	23-Jun	L	U	W,G	B/AL	Grand View
614-89680	23-Jun	L	U	W,Y	B/AL	Grand View
614-89681	23-Jun	HY	U	W,W	B/AL	Grand View
614-89682	23-Jun	L	U	W,P	B/AL	Grand View
614-89683	23-Jun	L	U	P,G	B/AL	Grand View
614-89684	25-Jun	HY	U	P,B	B/AL	Grand View
614-89685	26-Jun	L	U	P,G	B/AL	Grand View
614-89686	8-Jul	L	U	P,Y	B/AL	Grand View